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REPORT

OF

INSECT RECONNAISSANCE AND CONTROL PLAN

KAIBAB NATIONAL FOREST

BY

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PART I

THE SURVEY

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OBJECT

As a basis for future plans in the campaign against the Black Hills beetle infestation within the Kaibab National Forest and Grand Canyon National Park, an extensive survey of the entire timbered area was started immediately after the closing of the 1924 treating season. Work started on July August 25 and ended Sept.5, 1924. Since at least one side of nearly every section was examined it was only through the excellent cooperation of the members of the party that the survey was completed in so short a time. Four hundred miles of strip ten chains wide were examined. This makes 32000 acres or 9% of the whole timbered area of 363000 acres. In addition thirteen half sections ideally located for checks were worked similar to the 100% cruise employed during the treating season.With this acreage added,a 10% estimate was obtained by the survey party.

METHODS

In the extensive work each days run was started from a knownlocation, usually at a section corner established during the Forest Service timber reconnaissance of 1910. All trees of the 1923 infestation within five chains on either side of the compass line,were noted on the maps,and in addition the 1922 killed trees and those of previous years were counted,so as to give an idea of the percentage killed during this recent epidemic. At the end of every mile acre (circular) ~~acre~~ plots were taken and the total number of beetle killed standing trees compared with the number of living trees. As the total stand is known, the total loss was computed. In addition to the above work half sections ideally located as checks throughout the forest - one for every township- were cruised 100%. This work was conducted in the same manner as during the treating season with two spotters and a compassman. The 1923 trees only were blazed on the north side and numbered serially and listed on the map and record sheets,with their diamter breast high,number of logs and volume.

In the extensive samplestrips note was made of the forest type and size of infested groups as this gave an idea of the status of the infestation. All notes were consolidated on a township map. On these plats all the essential data were entered, such as intensity of infestation past years loss per section, location of strips run, size of groups, etc. The probable number of dead trees per section was obtained when using the ten chain strip, by multiplying the number of 1923 trees per mile by eight. The resulting figure was modified by the estimator depending upon whether

be considered the section uniform or not. It is obvious that the loss figure secured in this manner is only a rough approximation, but a closer estimate was not warranted by the extra expense.

The township plats with all the detail are on file with the Supervisor's copy of the report. All material was consolidated on the Kaibab 4" scale map for use outside of his office. The number of 1923 killed trees per section was also consolidated into townships and then made into a table which accompanies this report.

PERSONNEL

The crew consisted of S. S. VanBoskirk, Assistant Forest Supervisor, Archie L. Gibson, Forest Assistant, Wm. P. Osborne, Junior Forester, and O.L.Hokanson, a spotter during the treating season. When Mr. Osborne was transferred on August 10, Mr.Eugene Swapp, another spotter duringthe treating work was secured on August 13. Each man worked indivinually and averaged eight miles of strip a day. The work started in the Basin in T.35 N. and proceeded north.

COST

The work accomplished by the party amounted to estimating the number of 1923 insect infested trees and seeking the areas of concentration on the 363,000 acres of timberland . The survey amounted to a 10% estimate.

The cost of the field work is as follows:

Salaries	$740.17
Subsistence	173.31
Gas & Oil	20.00
Total	933.48

Cost per acre $.0025.

In passing it might be well to mention the fact that if a similar cruise is needed in the future an aeroplane survey could be made more accurate and quicker even though more expensive. With panchromatic films all the bug trees could then be counted and no estimations would be needed. During his visit to the Kaibab, Dr. Craighead mentioned that this aero-photography was successful in Canadian insect control work and was used by large Canadian paper companies.

S. S. VanBoskirk

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PART II

THE DATA SECURED.

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LOCATION OF AREA

The Kaibab insect control project is located on the Kaibab Plateau in northern Arizona on the north rim of the Grand Canyon. It comprises most of the Kaibab National Forest and the Grand Canyon National Park north of the river.

Yellow pine comprises approximately 25% of the total area in the forest, but forms over 80% of the merchantable timber. The pure yellow pine stand is found between 7,000 and 8,800 feet elevation. Above 8,800 feet the forest is composed of mixed type, Engelmann and Colorado Blue spruce, white, alpine and Douglas fir, and a small percentage of yellow pine. This type runs up to the summit of the plateau, to an elevation of 9,800 feet.

HISTORY OF THE AREA.

Destruction of yellow pine by the Black Hills beetle has been progressing on this forest for centuries. Stumps cut during control work show where the beetles have attacked the trees hundreds of years ago, with many periodic attacks since that time. The forest floor is strewn with decaying trunks showing the markings of the beetles. Standing trees near the groups of old killings often faithfully record, by their rings, the year in which the attack occurred, and following this an accelerated growth due to liberation from competition. In fact in the pure yellow pine type there has been very little loss of timber from any agency other than beetles. Fires burning through the green mature forest have scorched the trees and killed reproduction, but where they have burned through old "bug killings" complete destruction has occurred and pine has been temporarily replaced by aspen.

One of the earliest records of heavy insect losses is contained in the report of the Forest Service timber reconnaissance survey made in 1910. Over the entire forest a recent loss of 16,150,000 board feet was reported and old killings (undoubtedly due to beetles) amounting to 13,875,000 board feet. As a matter of interest these losses, reported in the cruise by quarter sections, have been plotted on a map of the area to show the location and status of the

infestation at that time. It is interesting to compare this map with the map showing the intensity and location of the infestation as determined by the recent survey of 1924.

During the period of 1914 to 1920 the forest supervisor reported that no infestations of any importance existed on the forest. Single trees were infested but nothing more.

In the fall of 1920, groups of dead and dying yellow pine were noticed on the north rim of the Grand Canyon and the destruction appeared to be on the increase. A preliminary examination indicated that the Black Hills beetle was the cause of the damage.

Funds were secured by the Forest and Park Service to have an examination made by experts of the Bureau of Entomology. In the summer and fall of 1921 such an examination was made. It was found that the beetles had been steadily increasing since 1919 and recommendations were made that artificial control be undertaken to prevent heavy losses on park areas most frequented by visitors, and along the highway thru the national forest.

In the spring of 1922 a small amount of money was secured by the Park and Forest Service for control work and a number of small areas in the Park and along the highway were treated. Altogether 5,683 trees were treated at a cost of $ 8,965.39.

Following this work, which was locally successful, it was found that the infestation was quite extensive and that very serious losses were being suffered in the northwestern portion of the forest. In 1923 an effort was made to stop this infestation and $ 9,620.25 was spent in the treating of 6,252 trees. Although this work succeeded in preventing a westerly spread, the amount of timber treated was so small in comparison with the total amount infested that very little was accomplished in the actual supression of the epidemic.

In the spring of 1924 a large appropriation was secured and a large block of timber in the northern portion of the forest, Greenland Plateau and a strip along the Grand Canyon Highway was cleaned up.

TIMBERED AREA AND RESOURCES INVOLVED.

There are approximately 363,000 acres of timberland on the plateau carrying a stand of timber conservatively estimated at 1,362,130 M.B.M. of which 1,101,375 M.B.M. is western yellow pine. There is practically no demand for this timber at present but it has a potential value of from three to six million dollars and also an aesthetic value, due to the proximity of the Grand Canyon National Park and the

Grand Canyon Highway which traverses the forest, that cannot be expressed in dollars and cents. Its protection, therefore, is of the utmost importance.

INSECTS RESPONSIBLE FOR DAMAGE.

The great destraction of western yellow pine timber in the forest is being caused primarily by the Black Hills beetle (Dendroctonus ponderosae Hopk.) There are many other insects associated with it such as Dendroctonus convexifrons D. approximatus and two or more species of Ips. None of these appear to cause primary damage.

There is no question as to the primary nature of the attacks of the Black Hills beetle. It appears to prefer thrifty, fast growing trees of the sapling, pole or "Black Jack" type. On the epidemic areas it kills everything from mature trees down to saplings two inches in diameter and is only stopped thru natural control factors after it has killed a percentage of the stand or is reduced thru artificial control work.

The adult Black Hills beetle is a small, stout, black beetle from one sixth to one fourth of an inch in length. On attacking the trees it enters the bark and between the bark and wood constructs a comparitively straight egg gallery paralleling the grain of the wood. Eggs are laid in niches along this tunnel. The larvae upon hatching feed out on either side completely cutting the sap flow and killing the tree.

The trees are attacked in August and September. The beetles, for the most part, winter as adults, eggs and young larvae. Egg laying and larval feeding continues the following spring and the new adults reach maturity in July. Flight occurs during the early part of August, the beetles leaving the old trees and flying to attack green ones. Ordinarily the flight is short, the beetles probably not flying over a half mile before attacking new trees.

EXTENT OF OLD LOSSES.

It is very evident from a study of the forest that the greatest losses in the past have been caused by insects. Throughout the area there is an abundance of down timber showing the markings made by the Black Hills beetle. Standing trees in the vicinity of these old killings indicate by their rings the date on which they were liberated from the competition of their neighbors and often at this point of liberation can be found the galleries of the beetles where they failed to kill these particular trees. In this way some of the old killings have been dated back 275 years.

In the report of the timber reconnaissance made in 1910, Messrs D.M.Lang and S.S.Stewart write as follows:- "Insect infestation has attained enormous proportions over the whole forest and the injury is going on steadily year

after year. The old fallen trunks, in all stages of decay, argue that this pest has been working for many decades, probably hundreds of years, and the extent of damage wrought is unequalled, even by fire" and in their estimates, out of the 1,362,130 M.B.M. of merchantable timber 16,150M.B.M. is listed as "bug killed" and as dead (probably older bug killed timber) 13,875 M.B.M. This is a similar picture to conditions as they exist on the forest today.

Later during 1915, the Forest Officers were not impressed with the insect loss and wrote in a Silvicultural Plan for the Forest, "Insect infestation of the timber in the Kaibab Forest is not prevalent at present. Some 10 years past the yellow pine timber on the Forest was attacked but apparently for one season only. The attack was confined to small areas scattered throughout the entire pine belt. The areas attacked ranging in size from 10 acres down. Collectively possibly 500 acres of timber were totally destroyed."

This difference of opinion may have been due to a decided decline in the losses during 1914 and 1915-1916 which made the insect losses appear inconspicuous.

The survey of this year shows that on the whole 12% of the yellow pine stand has been killed during the recent epidemic (since 1919). During this time 128,460 M.B.M. of yellow pine timber has been killed by the beetles.

RECENT LOSSES

By a combination of figures obtained through the check sections on the survey and the actual figures of the number of trees treated during the past season, 25000000 ft. B.M. was killed by the beetles during the 1923 attack or 81,980 individual trees. This gives an average of 69 bd.ft. per acre for the entire forest or 2.2% of the total pine stand.

The Black Hills beetle can be found any year killing a few trees scattered throughout this forest. When only a few scattered trees are killed each year and there is no tendency towards an increase the infestation is termed normal or "endemic". On the forest 100 trees killed per section per year or less appears to represent an endemic condition and has been plotted as such on the accompanying map. Any infestation in excess of 100 trees per section is termed "epidemic" and has been plotted according to intensity: from 100 to 500 trees per section has been colored yellow; 500 to 1000 in orange and over 1000 in red.

In studying the map several units will be noticed where the infestation has concentrated. They are as follows reading from north to south.

I. Jacob Lake Unit.

This area is east to the rim and north from the Jacob Lake Ranger Station for about three miles and south to the 1924 control work. The new infestation or the 1924 attack was heavier than the previous year as shown by the new trees found.

Perhaps this was more noticeable because the survey through thisterritory was the last to be completed.

2 Moquitch.

The second area and the most serious is south from the Jacob Lake Ranger Station to Oquor Canyon and Dry Park and west to within two and three miles of Nail Canyon. In many places practically the entire stand of pine has been killed. Approximately 18,000 acres and about 20,000 trees were treated on this area during 1924 so that the new attack has been confined to the Moquitch drainage and south. The new flight was just occurring when the survey party was camped on the ridge between Moquitch and Castle Canyons. The infestation was spreading west along this ridge but no new infestations were found more than a mile and a half west of the past heavy killings. The south end of this area in the vicinity of Dry Park is being cleaned up by a treating crew which is now operating in this vicinity.

3. Pleasant Valley.

The third place of concentration is east to the rim from Crane Lake south to Pleasant Valley. The Grand Canyon Highway passes along the west edge of the above described territory yet the infestation is very light within the view from the road. As shown by the 1910 infestation map this is the area w where the infestation was the heaviest at that time.

4. Kanabownits.

The fourth area is on the ridges bordering Kanabownits Canyon near the Grand Canyon National Park boundary. The infestation here has been extremely heavy in the past, from fifty to seventy five percent of the pine stand having been killed. However now even though classed as epidemic, the infestation is not spreading rapidly and is dieing out.

5. The Basin.

The fifth area is located along the Grand Canyon Highway about four to six miles north of the Park Ranger Station near Bright Angel Point. As this infestation was cleaned up during the 1924 campaign, 788 trees having been treated, no further work is anticipated here. This area will bear close watching since in a few instances some of the beetles escaped and attacked fresh trees, as the treating work was done after July 10.

6. Greenland Plateau.

The sixth area lies wholly within the Grand Canyon National Park on the Greenland Plateau. This area was treated during the 1924 control work. Nearly 5000 trees on approximately 6400 acres were treated. Conditions similar to those on the fifth area existed so that some of the beetles escaped due to the work being carried on too late. This area bears watching due to the escape of the insects.

CONTROL WORK ACCOMPLISHED

During the 1924 season 27780 trees were treated at a cost of $32000. Work started as soon as teams could get on the Forest or about April 15.

All operations ceased July 23. As stated previously this closing date is too late as some of the beetles were too far advanced and attacked fresh trees when liberated. A total of approximately 27,400 acres was covered 100% by the control operations. This means that a little more than 33% of all the infested trees as found by the recent reconnaissance were treated during this season. Two large camps with an average crew of thirty men each, did the work at average cost of $1.15 per tree. Six trees per man per day were the average for the entire campaign. One small camp of 15 men was operated in the Basin during July for fifteen days. This camp cleared the Grand Canyon Highway of infested trees in that locality.

* This includes the men engaged in treating work only and not the over head.

	1923 KILLINGS ENDEMIC	EPIDEMIC	1 LAST five years 2 KILLED	SINCE 1919 VOLUME XIII. ED B.B.M.
T 36 N. R. 1 W.	310	0	.97	360
T 37 N. R. 1 W.	320	0	1.38	380
T 38 N. R. 1 W.	20	0	1.00	20
T 34 N. R. 1 E.	240	0	3.11	690
T 35 N. R. 1 E.	1120	300	4.24	4,010
T 36 N. R. 1 E.	1200	2,330	2.92	3,370
T 37 N. R. 1 E.	860	7,660	4.00	3,600
T 38 N. R. 1 E.	730	1,850	2.25	1,270
T 39 N. R. 1 E.	245	0	.92	150
T 33 N. R. 2 W.	20	0	.65	0
T 34 N. R. 2 E.	1,350	650	14.68	12,500
T 35 N. R. 2 E.	1,056	1,060	11.52	5,160
T 36 N. R. 2 E.	1,020	2,450	19.70	5,290
T 37 N. R. 2 E.	320	24,720	45.60	51,550
T 38 N. R. 2 E.	460	14,520	25.60	18,750
T 39 N. R. 2 E.	1,200	1,110	.82	680
T 40 N. R. 2 E.	140	0	.91	90
T 33 N. R. 3 E.	850	140	5.00	2,600
T 34 N. R. 3 E.	1,660	615	20.20	7,950
T 35 N. R. 3 E.	470	0	10.50	3,920
T 36 N. R. 3 E.	400	1,970	32.10	10,300
T 37 N. R. 3 E.	560	2,185	6.85	1,360
T 32 N. R. 4 E.	330	0	.00	0
T 33 N. R. 4 E.	490	4,690	40.00	13,500
T 34 N. R. 4 E.	240	0	.50	50
	15,510	66,470	12.00	128,460

Endemic means less than 100 infested trees to section.

Epidemic " more " " " " " "

PART III

KAIBAB INSECT CONTROL PROJECT

RECOMMENDATIONS FOR WORK DURING 1925.

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During the summer of 1924, a field crew of the Forest Service made a reconnaissance of the Kaibab National Forest and Grand Canyon National Park to determine the amount and extent of the losses being caused by the Black Hills beetle. This survey was carried out under general instructions from the Bureau of Entomology as to the data to be secured.

During September a further general survey of the insect situation on this forest was made by the writer to determine the effectiveness of the recent control work and the relation of the new infestation to the losses of the past year.

On the basis of these surveys the present recommendations for control work during 1925 are based.

RESULTS OF PAST CONTROL WORK.

It is very evident that control has been secured on areas where a high percentage of the past infestation has been removed. Results appear to be in direct proportion to the thoroughness with which the infestation is removed.

In 1922 on the Kylie Point, Mr. Edmonston carried out the experiment of attempting to remove 100 % of the infestation. The unit showed excellent results and the infestation was reduced from 518 trees to 16 trees and has remained at a low point ever since. On the other units treated the recurring infestation was almost identical to the amount of infestation left on the area.

In 1923, the early work on the western edge of the Woonitch and Corral Lake units where a high percentage of the infestation was removed, showed a high reduction and appears to have prevented the infestation from moving west into clean territory. Where only the large infested trees were removed only about a 50% reduction was secured.

ACCOMPLISHMENTS DURING 1924

During the spring of 1924, approximately 18,000 acres on the northern end of the Kaibab plateau was covered with control work. On this area 20,000 infested trees were cut and peeled.

Along the Grand Canyon highway a few miles north of Bright Angel Point, about 800 trees were cut on 3,000 acres.

Within the Grand Canyon National Park, on Greenland Plateau, about 5,000 trees were treated on 6400 acres.

Altogether about 25,800 trees and 2,000 poles under 10 inches in diameter were cut during the control season at a cost of approximately $32,000.

Examination of these areas shows very excellent reductions in the areas treated north and east of Tilo and a Half. When the work closed down heavy infestations were left to the south of the worked area. It appears that these broods have not travelled more than a half mile back into the worked area and successfully established themselves. On Greenland Plateau and along the highway it appears that the broods were too far developed to be entirely killed. Some of the adults undoubtedly were shaded by slabs of bark and escaped. These have established themselves in green timber so that although a very large reduction was secured there are still some infesting broods left on these areas. For instance on Greenland Plateau where 5,000 trees were treated, there will probably be about 1,000 newly infested trees.

At the present time the Park area as a whole is practically free from infestation. If it had been possible to more completely clean up the infestation on Greenland Plateau and along the highway, it is probable that no further work would have been needed for many years.

It therefore appears that thorough removal of the beetle broods over a wide area if carried out before the beetles mature, will successfully control infestations of the Black Hills beetle.

CONTROL RECOMMENDATIONS FOR 1925.

The work of this past year has shown that it is feasible to free from infestation a large area of timber thru control work. It is therefore entirely practical to clean up all epidemic areas on the Kaibab Plateau this coming season, provided adequate funds are available for the fiscal year 1925.

The survey of this year shows a total of about 67,000 trees attacked and killed in 1923 on epidemic areas. Of this number 27,800 were cut in the control work and 39,200 left untreated. Assuming that the trees attacked during the fall of this year will equal those left at the end of the past control season, there will be about 40,000 trees requiring treatment during the spring season of 1925.

The cost of this work at $1.25 per tree(average cost for the past year) would be $50,000. The question as to whether such an expense is justified by the timber values , both commercial and aesthetic, which are menaced, is one for the Forest Service and Park Service to determine.

It is very probable that if the work is not done, the beetles will continue to sweep thru the pine timber on the northwestern portion of the forest killing from 10% to 90% of the stand over large areas, and that the results accomplished thru control during the past three years will be nullified within a year or so by the beetles working back from infested territory into the cleaned areas.

If the Forest Service and Park Service decide that control work should be continued until the forest is freed from epidemic losses, then the following plan of control is recommended:-

(1) Area- The treating of infested timber over all areas, as shown by the map accompanying the survey report, which contain more than 100 infested trees per section is recommended. This includes the territory north and east of Jacob Lake; from Mile and a Half south to Dry Park; and the territory east of Crane Lake and Pleasant Valley. Within the Grand Canyon National Park, although some new infestation has developed from beetles which escaped, due to the late treating work, it is felt that such a good reduction has been secured that the park area can safely be left for another year without additional work. It has been the history in many other cases that an additional reduction was secured the second year after control work. It is therefore, worth waiting one year at least, to see what develops before doing additional work in the park.

(2) Amount To Be Treated- Assuming that the new infestation is no greater nor less than the past year's loss, there will be approximately 40,000 infested trees to be treated in the spring of 1925. (A further survey is now being conducted by the writer to check this estimate.)

(3) Time of Treatment. The period of control work should be from the earliest date at which it is feasible to get a crew of men on the mountain, until June 30th. The experience of this year indicates that unless some other method of treatment is developed, good results can not be secured from the peeling after June 30th.

(4) Methods. An experimental camp is now being conducted to determine if improvements can be made over the methods which have been used in the past and it is quite possible that a method will be developed which will prove effective and more economical than the present method of felling the trees and peeling the bark. Until the results of this work are available it is recommended that the peeling method be continued.

(5) Cost. Assuming that the method used during the past spring is continued, it will cost, at the rate of $1.25 per tree (average for past season's work), $50,000 to treat the estimated number of 40,000 trees. If from the standpoint of forest sanitation it is desired that the trees be trimmed

and the brush spread, an additional 15 cents per tree should be allowed, or a total of $56,000 appropriated for the fiscal year ending June 30,1925.

(6) Number of Camps. The work can probably best be handled with three large camps of about 45 men to treat the heavy centers from Mile and a Half south to Dry Park and one smaller camp of about 20 men to take care of the more scattered infestation east of Jacob Lake, Crane Lake and Pleasant Valley.

If funds cannot be secured to make a clean up of the area this coming season, a make shift plan would be to clean up a belt of timber about two miles wide around the heavy centers to keep the beetles from spreading. Such work would only afford temporary relief, for the beetles within such a zone would not be likely to die out, and after killing most of the timber within such an area would undoubtedly seek new fields of activity. Such a plan would involve the reclearing of the protective strip each year and in the long run would be both expensive and of doubtful benefit.

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Kanab, Utah.
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